INDOOR AIR QUALITY ASSESSMENT

Douglas G. Waybright Elementary School
25 Talbot St
Saugus, MA 01906

Prepared by:
Massachusetts Department of Public Health
Center for Environmental Health
Emergency Response/Indoor Air Quality Program

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Background/Introduction

At the request of parents, the Massachusetts Department of Public Health (MDPH), Center for Environmental Health (CEH) was requested to provide assistance and consultation regarding indoor air quality at each of Saugus's public schools, the majority of which took place over the spring of 2006. These assessments were jointly coordinated through Sharon McCabe, Director of the Saugus Health Department, and Ralph Materissi, Building Maintenance Director, Town of Saugus. The remainder of the Saugus public schools will be scheduled over the fall of 2006. On April 27, 2006 the Waybright Elementary School (WES) was visited by Cory Holmes, an Environmental Analyst in CEH's Emergency Response/Indoor Air Quality (ER/IAQ) Program to conduct an assessment.

The WES is a two-story red brick building constructed in 1964. No additions or renovations have been made to the building, therefore the majority of building components are original (e.g., floor/ceiling tiles, ventilation equipment). Windows were reportedly replaced over the summer of 2005. The building contains general classrooms, music room, library, art room, office space, kitchen, and an all-purpose room used as the cafeteria, gymnasium and auditorium. Windows are openable throughout the building.

The school was previously evaluated in January of 1998 by Covino Environmental Associates, Inc. (Covino), an environmental consultant. Covino inspected mechanical ventilation equipment and conducted general IAQ testing for carbon monoxide, carbon dioxide, volatile organic compounds and respirable particulates. Covino made the following recommendations based on their findings:

- Increase the supply of outdoor air to occupied spaces;

- Inspect and replace univent filters;
- Clean the interior of univents;
- Inspect mechanical equipment and pneumatic system of univents for proper operation;
- Reconnect actuator bar to the outdoor air damper of the univent in room 1;
- Remove debris from air intakes and install screens on air intake ducts for first floor univents (Covino, 1998a).

In September of 1998 Covino conducted monitoring for airborne asbestos fibers and airborne mold at the WES. The Covino report indicated that no asbestos was detected in any of the air samples taken and that indoor concentrations of mold were less than outdoor mold concentrations and that no corrective actions appeared necessary at that time (Covino, 1998b).

Methods

Air tests for carbon monoxide, carbon dioxide, temperature and relative humidity were taken with the TSI, Q-Trak, IAQ Monitor, Model 8551. Air tests for airborne particle matter with a diameter less than 2.5 micrometers were taken with the TSI, DUSTTRAK™ Aerosol Monitor Model 8520. Screening for total volatile organic compounds (TVOCs) was conducted using a Hnu, Model 102 Snap-on Photo Ionization Detector (PID). CEH staff also performed a visual inspection of building materials for water damage and/or microbial growth.

Results

The WES houses approximately 285 students in grades K-5 and has a staff of approximately 25. Tests were taken under normal operating conditions; however some classrooms were unoccupied due to students attending class field trips. Test results appear in Table 1.

Discussion

Ventilation

It can be seen from Table 1 that carbon dioxide levels were elevated above 800 parts per million (ppm) parts of air in five of twenty areas surveyed, indicating inadequate air exchange in these areas surveyed on the day of the assessment. However, a number of areas with carbon dioxide levels below 800 ppm were sparsely populated, unoccupied or had windows open. Low occupancy and open windows can greatly reduce carbon dioxide levels. Carbon dioxide levels would be expected to be higher with full occupancy and with windows closed. It is also important to note that the mechanical ventilation system was deactivated throughout the building at the time of the assessment, therefore no means to mechanically introduce fresh, outside air was being provided.

Fresh air in classrooms is supplied by unit ventilator (univent) systems (Picture 1). A univent draws air from the outdoors through a fresh air intake located on the exterior wall of the building (Picture 2) and returns air through an air intake located at the base of each unit (Figure 1). Fresh and return air are mixed, filtered, heated and provided to classrooms through an air diffuser located in the top of the unit. As mentioned, all univents had been deactivated at the time of the assessment and were reported to be used as heating units only (e.g., during fall/winter). Obstructions to airflow, such as papers and books stored on univents and items placed in front of univent returns, were seen in a number of classrooms (Picture 3). In order for univents to provide fresh air as designed, these units must be activated and allowed to operate while rooms are occupied. Univent return vents and diffusers must also remain free of obstructions.

Exhaust ventilation is provided by vents located on the rear side of an interior wall/divider in each classroom (Pictures 4 and 5). Vents are ducted beneath classrooms out an exhaust grill located on the exterior of the building (Picture 6). The exhaust vents are prone to obstruction by items placed or hung in front of the vents (Picture 5). In addition, the location of the vents is not conducive to air exchange (e.g., on the opposite side of the wall to univents and occupants), reducing the effectiveness of the exhaust vent to remove common environmental pollutants from the classroom itself. As with the univents, in order to function properly, exhaust vents must remain free of obstructions.

To maximize air exchange, the MDPH recommends that both supply and exhaust ventilation operate continuously during periods of occupancy. In order to have proper ventilation with a mechanical ventilation system, the systems must be balanced subsequent to installation to provide an adequate amount of fresh air to the interior of a room while removing stale air from the room. It is recommended that HVAC systems be re-balanced every five years to ensure adequate air systems function (SMACNA, 1994). The date of the last balancing was unknown at the time of the assessment. However in subsequent conversation with Ralph Materissi, Building Maintenance Director, Town of Saugus, an HVAC engineering firm, Johnson Controls Inc., was contracted to inspect and make recommendation for repair of mechanical ventilation systems.

The Massachusetts Building Code requires that each room have a minimum ventilation rate of 15 cubic feet per minute (cfm) per occupant of fresh outside air or have openable windows (SBBRS, 1997; BOCA, 1993). The ventilation must be on at all times that the room is occupied. Providing adequate fresh air ventilation with open windows and maintaining the temperature in the comfort range during the cold weather season is impractical. Mechanical ventilation is usually required to provide adequate fresh air ventilation.

Carbon dioxide is not a problem in and of itself. It is used as an indicator of the adequacy of the fresh air ventilation. As carbon dioxide levels rise, it indicates that the ventilating system is malfunctioning or the design occupancy of the room is being exceeded. When this happens, a buildup of common indoor air pollutants can occur, leading to discomfort or health complaints. The Occupational Safety and Health Administration (OSHA) standard for carbon dioxide is 5,000 parts per million parts of air (ppm). Workers may be exposed to this level for 40 hours/week, based on a time-weighted average (OSHA, 1997).

The MDPH uses a guideline of 800 ppm for publicly occupied buildings. A guideline of 600 ppm or less is preferred in schools due to the fact that the majority of occupants are young and considered to be a more sensitive population in the evaluation of environmental health status. Inadequate ventilation and/or elevated temperatures are major causes of complaints such as respiratory, eye, nose and throat irritation, lethargy and headaches. For more information concerning carbon dioxide, see Appendix A.

Temperature readings ranged from 71° F to 75° F in occupied areas, which were within the MDPH comfort guidelines the day of the assessment. The MDPH recommends that indoor air temperatures be maintained in a range of 70^{o} F to 78^{o} F in order to provide for the comfort of building occupants. In many cases concerning indoor air quality, fluctuations of temperature in occupied spaces are typically experienced, even in a building with an adequate fresh air supply. It is also difficult to control temperature and maintain comfort without operating the ventilation equipment as designed (univents deactivated/obstructed, exhaust vents blocked).

The relative humidity measurements ranged from 27 to 39 percent, which were near or below the lower end of the MDPH recommended comfort range. The MDPH recommends a comfort range of 40 to 60 percent for indoor air relative humidity. Relative humidity levels in the building would be expected to drop during the winter months due to heating. The sensation of dryness and irritation is common in a low relative humidity environment. Low relative humidity is a very common problem during the heating season in the northeast part of the United States.

Microbial/Moisture Concerns

During the assessment open utility holes in exterior walls were observed (Picture 7). Repeated water penetration can result in the chronic wetting of building materials and potentially lead to microbial growth.

Plants were noted in several classrooms. Plants can be a source of pollen and mold, which can be respiratory irritants for some individuals. Plants should be properly maintained and equipped with drip pans. Plants should also be located away from ventilation sources (e.g., univent diffusers) to prevent the entrainment and/or aerosolization of dirt, pollen or mold.

Other IAQ Evaluations

Indoor air quality can be negatively influenced by the presence of respiratory irritants, such as products of combustion. The process of combustion produces a number of pollutants. Common combustion emissions include carbon monoxide, carbon dioxide, water vapor and smoke (fine airborne particle material). Of these materials, exposure to carbon monoxide and particulate matter with a diameter of 2.5 micrometers (μm) or less (PM2.5) can produce immediate, acute health effects upon exposure. To determine whether combustion products were present in the school environment, CEH staff obtained measurements for carbon monoxide and PM2.5.

Carbon monoxide is a by-product of incomplete combustion of organic matter (e.g., gasoline, wood and tobacco). Exposure to carbon monoxide can produce immediate and acute health affects. Several air quality standards have been established to address carbon monoxide and prevent symptoms from exposure to these substances. The MDPH established a corrective action level concerning carbon monoxide in ice skating rinks that use fossil-fueled ice resurfacing equipment. If an operator of an indoor ice rink measures a carbon monoxide level over 30 ppm, taken 20 minutes after resurfacing within a rink, that operator must take actions to reduce carbon monoxide levels (MDPH, 1997).

The American Society of Heating Refrigeration and Air-Conditioning Engineers (ASHRAE) has adopted the National Ambient Air Quality Standards (NAAQS) as one set of criteria for assessing indoor air quality and monitoring of fresh air introduced by HVAC systems (ASHRAE, 1989). The NAAQS are standards established by the US EPA to protect the public health from six criteria pollutants, including carbon monoxide and particulate matter (US EPA, 2000a). As recommended by ASHRAE, pollutant levels of fresh air introduced to a building should not exceed the NAAQS levels (ASHRAE, 1989). The NAAQS were adopted by reference in the Building Officials & Code Administrators (BOCA) National Mechanical Code of 1993 (BOCA, 1993), which is now an HVAC standard included in the Massachusetts State Building Code (SBBRS, 1997). According to the NAAQS, carbon monoxide levels in outdoor air should not exceed 9 ppm in an eight-hour average (US EPA, 2000a).

Carbon monoxide should not be present in a typical, indoor environment. If it *is* present, indoor carbon monoxide levels should be less than or equal to outdoor levels. On the day of assessment, outdoor carbon monoxide concentrations were non-detect (ND) (Table 1). Carbon monoxide levels measured in the school were ND, with the exception of the boiler room where a slight carbon monoxide level of 2 ppm was measured (Table 1). The presence of the hot water heater and boiler equipment in this area is the likely source of the recorded carbon monoxide level. Occupants of the WES have reportedly expressed concerns regarding carbon monoxide and fuel odors near the boiler room. In response, a carbon monoxide detector has been mounted on the wall directly outside the boiler room (Picture 8). CEH staff observed conditions in the boiler room and found the interior door propped open (Picture 9) and observed a space below the stairwell door (Picture 10), which can serve as pathways for boiler room odors and combustion products into adjacent areas of the building. No odors were detected by or reported to CEH staff during the assessment.

The US EPA has established NAAQS limits for exposure to particulate matter. Particulate matter is airborne solids that can be irritating to the eyes, nose and throat. The NAAQS originally established exposure limits to particulate matter with a diameter of 10 μm or less (PM10). According to the NAAQS, PM10 levels should not exceed 150 microgram per cubic meter (μg/m^3) in a 24-hour average (US EPA, 2000a). These standards were adopted by both ASHRAE and BOCA. Since the issuance of the ASHRAE standard and BOCA Code, US EPA proposed a more protective standard for fine airborne particles. This more stringent PM2.5 standard requires outdoor air particle levels be maintained below 65 $\mu g/m^3$ over a 24-hour average (US EPA, 2000a). Although both the ASHRAE standard and BOCA Code adopted the PM10 standard for evaluating air quality, MDPH uses the more protective PM2.5 standard for evaluating airborne particulate matter concentrations in the indoor environment.

Outdoor PM2.5 concentrations were measured at 10 $\mu g/m^3$ (Table 1). PM2.5 levels within the school ranged from 10 to 19 $\mu g/m^3$, which were below the NAAQS of 65 $\mu g/m^3$ (Table 1). Frequently, indoor air levels of particulates can be at higher levels than those measured outdoors. A number of mechanical devices and/or activities that occur in schools can generate particulates during normal operation. Sources of indoor airborne particulate may include but are not limited to particles generated during the operation of fan belts in the HVAC system, cooking in the cafeteria stoves and microwave ovens; use of photocopiers, fax machines and computer printing devices, operating an ordinary vacuum cleaner and heavy foot traffic indoors.

Indoor air quality can also be negatively influenced by the presence of materials containing volatile organic compounds (VOCs). VOCs are carbon-containing substances that have the ability to evaporate at room temperature. Frequently, exposure to low levels of total VOCs (TVOCs) may produce eye, nose, throat and/or respiratory irritation in some sensitive individuals. For example, chemicals evaporating from a paint can stored at room temperature would most likely contain VOCs. In an effort to determine whether VOCs were present in the building, air monitoring for TVOCs was conducted during the assessment. An outdoor air sample was taken for comparison. Outdoor TVOC concentrations were ND (Table 1). Indoor TVOC concentrations were also ND (Table 1).

In an effort to identify materials that can potentially increase indoor TVOC concentrations, CEH staff examined classrooms for products containing these respiratory irritants. Several classrooms contained dry erase boards and dry erase board markers, and many dry erase board trays contained dry erase particles. Materials such as dry erase markers and dry erase board cleaners may contain VOCs, such as methyl isobutyl ketone, n-butyl acetate and butyl-cellusolve (Sanford, 1999), which can be irritating to the eyes, nose and throat.

Cleaning products were found on countertops and in unlocked cabinets beneath sinks in some classrooms (Picture 11). Like dry erase materials, cleaning products contain VOCs and other chemicals that can be irritating to the eyes, nose and throat of sensitive individuals.

In an effort to reduce noise from sliding chairs, tennis balls had been sliced open and placed on chair legs (Picture 12). Tennis balls are made of a number of materials that are a source of respiratory irritants. Constant wearing of tennis balls can produce fibers and cause TVOCs to off-gas. Tennis balls are made with a natural rubber latex bladder, which becomes abraded when used as a chair leg pad. Use of tennis balls in this manner may introduce latex dust into the school environment. Some individuals are highly allergic to latex (e.g., spina bifida patients) (SBAA, 2001). It is recommended that the use of materials containing latex be limited in buildings to reduce the likelihood of symptoms in sensitive individuals (NIOSH, 1997). A question and answer sheet concerning latex allergy is attached as Appendix B (NIOSH, 1998).

Other conditions that can affect indoor air quality were noted during the assessment. A number of personal fans, ceiling and wall-mounted exhaust vents were occluded with dust (Pictures 13 through 15). Dust can be a source for eye and respiratory irritation. If exhaust vents are not functioning, backdrafting can occur and aerosolize dust particles. Dust particles can also be aerosolized when fans are activated. Once aerosolized, these materials can accumulate on flat surfaces (e.g., desktops, shelving and carpets) in occupied areas and subsequently become re-aerosolized, causing further irritation.

Univent filters are reportedly changed once a year. CEH staff inspected and found univent filters in a number of areas to be coated with dirt/dust (Picture 16). A debris-saturated filter can obstruct airflow and may serve as a reservoir of particulates that can be re-aerosolized and distributed to occupied areas via the ventilation system.

Also of note was the amount of materials stored inside classrooms. In some classrooms items were observed on windowsills, tabletops, counters, univents, bookcases and desks. The stored materials in classrooms provide surfaces for dust to accumulate. Accumulation of these items (e.g., papers, folders, boxes) makes cleaning difficult for custodial staff. A few areas had missing ceiling tiles (Pictures 17), which can serve as a means for dusts and particulates to migrate into occupied areas.

An inactive insect nest was observed in one classroom (Picture 18). Nests can contain bacteria and may be a source of allergenic material. Nests should be placed in resealable bags to prevent aerosolization of allergenic material.

Lastly, pungent odors were reported from the closet of classroom 4. CEH staff examined conditions in the closet and traced the odor to a food jar that was being used for storage of items (Picture 19). It was recommended that the container be discarded and that all porous items (e.g., books, paper) that may have absorbed odors attempt to be aired out or discarded. Reuse of food containers is not recommended since food residue adhering to the surface may become a source for odors and/or serve to attract pests.

Conclusions/Recommendations

In view of the findings at the time of the visit, the following recommendations are made:

1. Continue with plans to have an HVAC engineering firm evaluate the ventilation system. Considering the age, condition and configuration of the HVAC system, an evaluation is strongly recommended for proper operation and/or repair/replacement of the ventilation system.
2. Operate all ventilation systems that are operable throughout the building (e.g., gym, auditorium, classrooms) *continuously* during periods of school occupancy independent of thermostat control to maximize air exchange.
3. Remove all obstructions from univents and exhaust vents to facilitate airflow. Remove coat hooks in front of exhaust vents.
4. Close classroom doors to improve air exchange.
5. Examine the feasibility of relocating exhaust vents to the occupied side of the interior wall/divider (Picture 4).
6. Replace exhaust grills on the exterior of the building (Picture 6) to improve exhaust capabilities.
7. Use openable windows in conjunction with mechanical ventilation to introduce fresh air. Care should be taken to ensure windows are properly closed at night and weekends to avoid the freezing of pipes and potential flooding.
8. Consider adopting a balancing schedule for mechanical ventilation systems every 5 years, as recommended by ventilation industrial standards (SMACNA, 1994).
9. For buildings in New England, periods of low relative humidity during the winter are often unavoidable. Therefore, scrupulous cleaning practices should be adopted to

minimize common indoor air contaminants whose irritant effects can be enhanced when the relative humidity is low. To control for dusts, a high efficiency particulate arrestance (HEPA) filter equipped vacuum cleaner in conjunction with wet wiping of all surfaces is recommended. Drinking water during the day can help ease some symptoms associated with a dry environment (e.g., throat and sinus irritations).

10. Seal open utility holes/breaches on the exterior of the building to prevent water infiltration and pest entry.

11. Ensure plants have drip pans. Examine drip pans periodically for mold growth and disinfect with an appropriate antimicrobial where necessary. Remove plants from the air stream of univents.

12. Store cleaning products properly and out of reach of students. Ensure spray bottles are properly labeled.

13. Keep boiler room doors closed and install weather stripping underneath hallway door (shown in Pictures 8 and 10) to prevent the migration of odors and particulates.

14. Test and replace carbon monoxide detector(s) as per the manufacture's recommendations to ensure proper working order.

15. Consider changing univent filters on a more frequent basis to prevent reduced airflow to classrooms. Vacuum interior of units prior to activation to prevent the aerosolization of dirt, dust and particulates.

16. Replace missing ceiling tiles to prevent the egress of drafts, odors and particulate matter into occupied areas.

17. Relocate or consider reducing the amount of materials stored in classrooms to allow for more thorough cleaning. Clean items regularly with a wet cloth or sponge to prevent excessive dust build-up.
18. Clean exhaust/return vents and personal fans periodically of accumulated dust to prevent the aerosolization of dirt, dust and particulates.
19. Store nests in resealable bags, away from ventilation sources.
20. Ensure food container is removed from coat closet in classroom 4 and that any porous items (e.g., books, paper) that may have absorbed odors are aired out or discarded.
21. Consider discontinuing the use of tennis balls on chair legs to prevent latex dust generation. Alternative "glides" can commonly be purchased from office supply stores; see Picture 20 for an example.
22. Consider adopting the US EPA document, *Tools for Schools* (US EPA, 2000b), as a means to maintaining a good indoor air quality environment in the building. This document can be downloaded from the Internet at http://www.epa.gov/iaq/schools/index.html.
23. Refer to resource manuals and other related indoor air quality documents for further building-wide evaluations and advice on maintaining public buildings. Copies of these materials are located on the MDPH's website: http://mass.gov/dph/indoor_air

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Picture 1

Classroom Univent

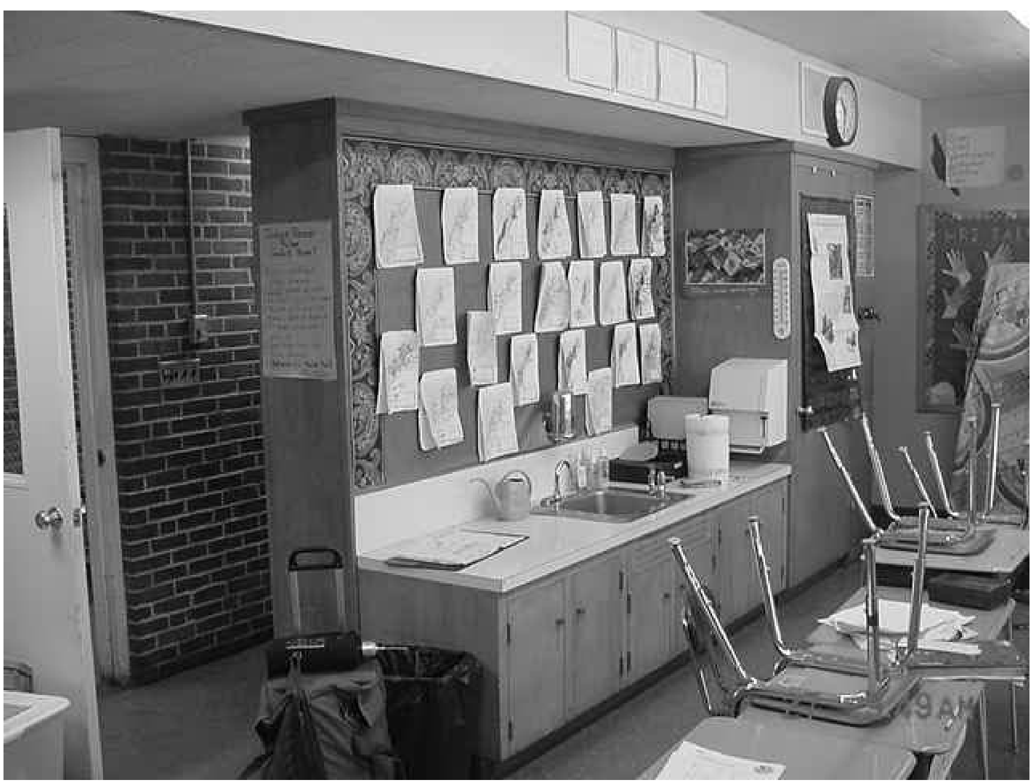
Picture 2

Univent Fresh Air Intake

Picture 3

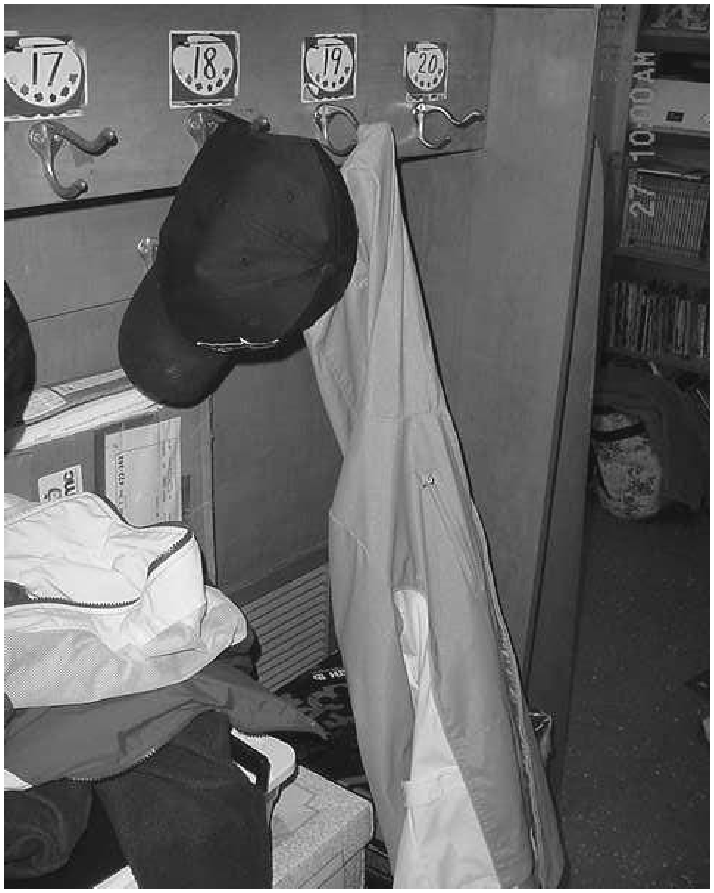
Items Obstructing Univent Air Diffuser and Return Vent (Bottom Front)

Picture 4



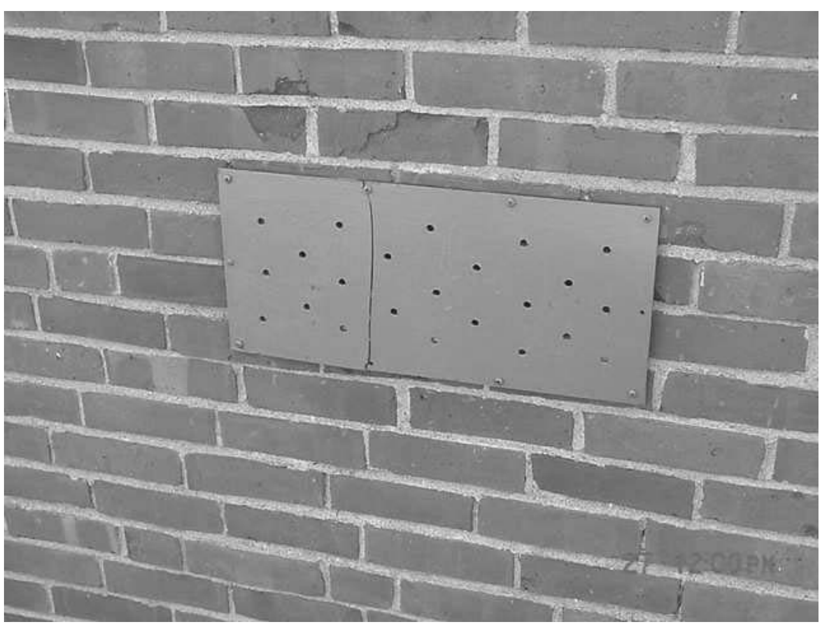
Interior Wall/Divider, Note Exhaust Vent on the Opposite Side of Wall

Picture 5



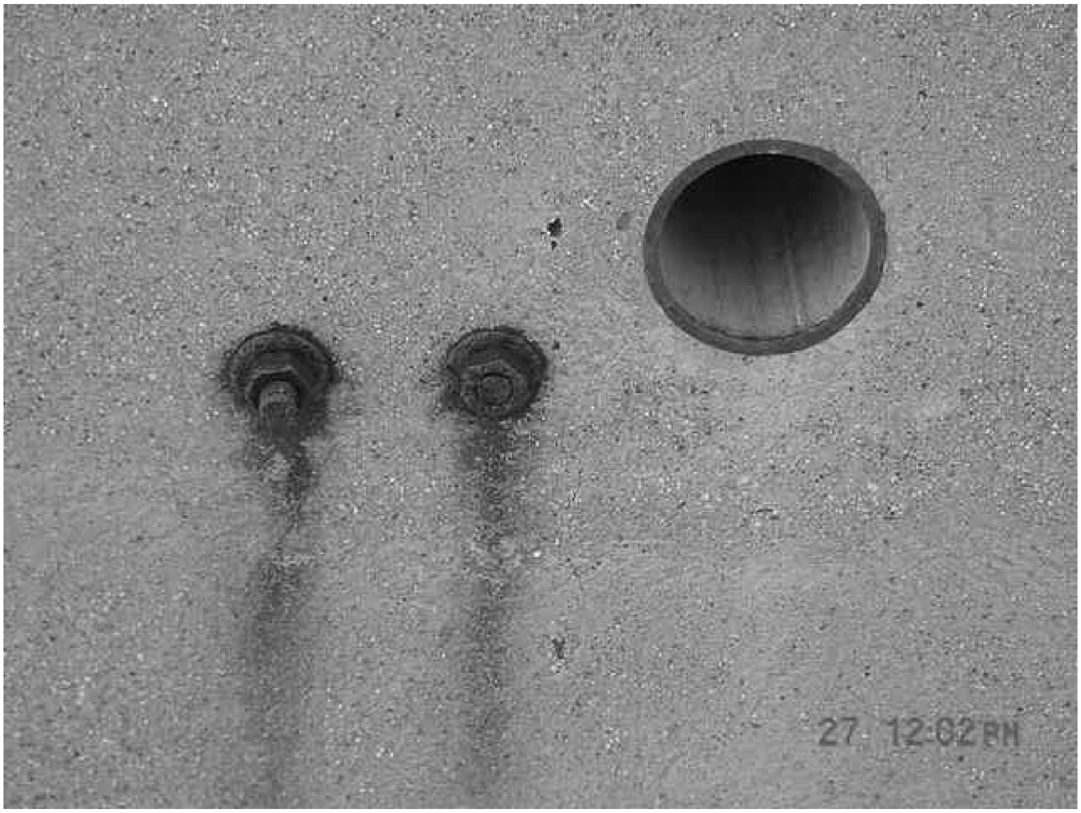
Exhaust Vent on the Opposite Side of Wall Interior Wall/Divider, Note Coat Hooks and Partially Obstructed Vent

Picture 6



Exterior Exhaust Vent, Note Small Holes (Limiting Airflow) in Plywood Serving as a Grill

Picture 7



Open Utility Hole on Exterior of Building

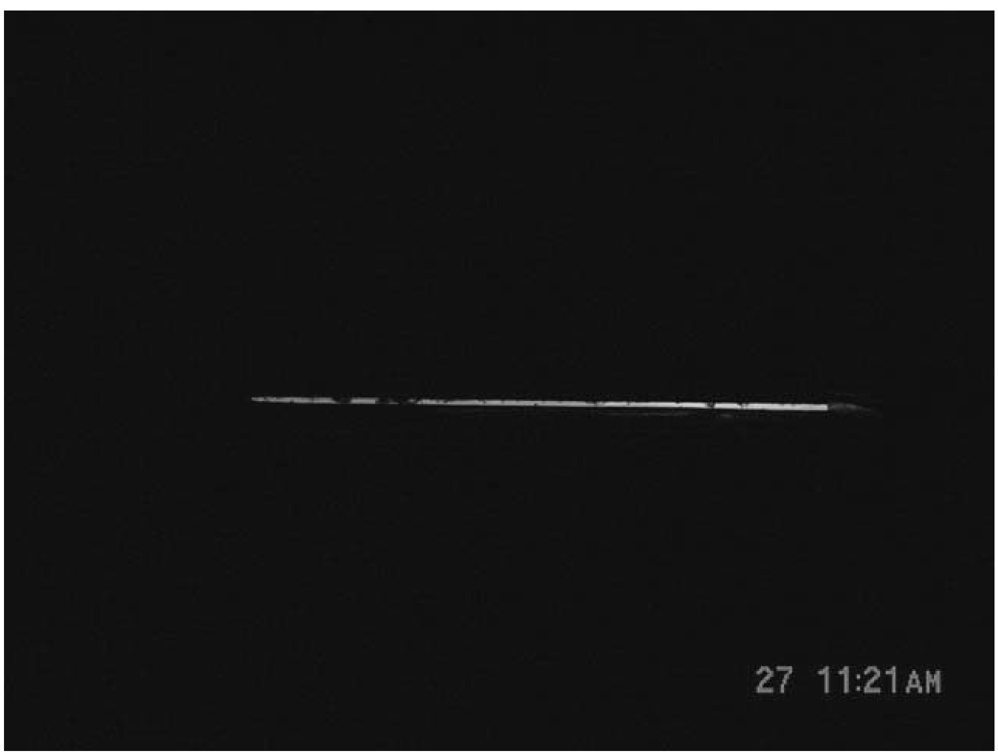
Picture 8

Carbon Monoxide Detector outside of Boiler Room

Picture 9

Interior Door to Boiler Room Propped Open

Picture 10



Light Penetrating Through Space below Boiler Room Stairwell Door to Main Hallway

Picture 11

Spray Cleaning Product on Counter of Classroom

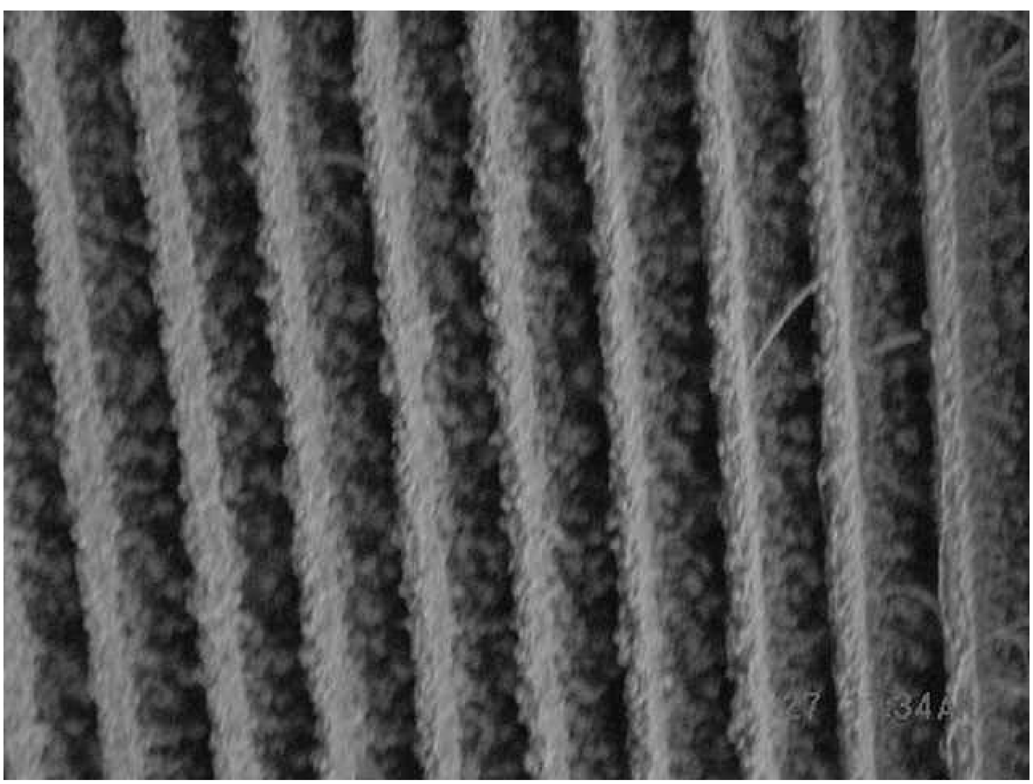
Picture 12

Tennis Balls on Chair Legs

Picture 13

Wall-Mounted Exhaust Vent Occluded with Dust

Picture 14



Ceiling-Mounted Exhaust Vent Occluded with Dust

Picture 15

Personal Fan Occluded with Dust

Picture 16

Univent Filter Occluded with Dust

Picture 17

Missing Ceiling Tile in Special Education Classroom

Picture 18

Inactive Bee/Wasp Nest in Classroom

Picture 19

Food Container in Coat Closet of Classroom 4

Picture 20

“Glides” for Chair Legs that can be used as an Alternative to Tennis Balls

Douglas Waybright School | **Indoor Air Results**

25 Talbot Street, Saugus, MA 01906 | **Date: 04/27/2006**

Table 1

Location/ Room	Occupants in Room	Temp (°F)	Relative Humidity (%)	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	TVOCs (ppm)	PM2.5 (μg/m3)	Windows Openable	Ventilation Supply	Ventilation Exhaust	Remarks
background	0	59	38	398	ND	ND	10	N			mostly sunny, wind ENE 10-15 mph.
7	0	72	36	590	ND	ND	13	Y # open: 0 # total: 3	Y univent (off)	Y wall dust/debris	Hallway DO, PF, TB, plants, dusty UV filter, class on field trip.
12	0	72	32	546	ND	ND	12	Y # open: 1 # total: 3	Y univent (off)	Y wall dust/debris	Hallway DO, PF, cleaners, class at field trip.
8	24	74	36	1374	ND	ND	15	Y # open: 0 # total: 3	Y univent (off)	Y wall boxes items	DEM.
9	20	74	32	825	ND	ND	13	Y # open: 3 # total: 3	Y univent (off) items	Y wall items	Hallway DO, TB, cleaners.
10	26	72	29	625	ND	ND	14	Y # open: 3 # total: 3	Y univent (off)	Y wall items	Hallway DO, DEM, PF.

ppm = parts per million
μg/m3 = micrograms per cubic meter

AD = air deodorizer
AP = air purifier
aqua. = aquarium

AT = ajar ceiling tile
BD = backdraft
CD = chalk dust
CP = ceiling plaster
CT = ceiling tile
DEM = dry erase materials

design = proximity to door
FC = food container
G = gravity
GW = gypsum wallboard
M = mechanical
MT = missing ceiling tile

NC = non-carpeted
ND = non detect
PC = photocopier
PF = personal fan
plug-in = plug-in air freshener
PS = pencil shavings

sci. chem. = science chemicals
TB = tennis balls
terra. = terrarium
UF = upholstered furniture
VL = vent location
WP = wall plaster

Comfort Guidelines

Carbon Dioxide: < 600 ppm = preferred
600 - 800 ppm = acceptable
> 800 ppm = indicative of ventilation problems

Temperature: 70 - 78 °F
Relative Humidity: 40 - 60%

Douglas Waybright School | **Indoor Air Results**

25 Talbot Street, Saugus, MA 01906 | **Date: 04/27/2006**

Table 1

Location/ Room	Occupants in Room	Temp (°F)	Relative Humidity (%)	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	TVOCs (ppm)	PM2.5 (µg/m3)	Windows Openable	Ventilation		Remarks
									Supply	Exhaust	
4	22	74	32	789	ND	ND	12	Y # open: 1 # total: 3	Y univent (off)	Y wall items	Hallway DO, DEM, items, odor complaints from closet.
11	27	72	30	644	ND	ND	12	Y # open: 3 # total: 3	Y univent (off) items	Y wall items	Hallway DO, DEM, TB.
5	12	74	29	684	ND	ND	16	Y # open: 0 # total: 0	Y univent (off)	Y wall	DEM, wall to wall carpet.
2	2	73	32	714	ND	ND	12	Y # open: 2 # total: 3	Y univent (off) boxes furniture	Y wall	Hallway DO, 11 occupants gone 20 mins.
3	24	73	39	1403	ND	ND	12	Y # open: 0 # total: 3	Y univent (off)	Y wall items	Hallway DO, PF.
1	14	72	38	1134	ND	ND	13	Y # open: 0 # total: 3	Y univent (off)	Y wall items	PF, TB.

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Douglas Waybright School | **Indoor Air Results**

25 Talbot Street, Saugus, MA 01906 | **Date: 04/27/2006**

Table 1

Location/ Room	Occupants in Room	Temp (°F)	Relative Humidity (%)	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	TVOCs (ppm)	PM2.5 (µg/m3)	Windows Openable	Ventilation		Remarks
									Supply	Exhaust	
6	18	74	34	887	ND	ND	11	Y # open: 0 # total: 3	Y univent (off)	Y wall	Hallway DO, DEM, TB, nests.
boiler room	0	77	32	542	2	ND	10	N	Y	N	odors in hallway/adjacent classrooms reported, CO monitor installed in hallway, no odors in boiler room or hallway during assessment,space under hallway door-light penetration.
reading room	0	75	29	634	ND	ND	11	Y # open: 0 # total: 1	Y univent (off)	N	Hallway DO, DEM, PF.
spec ed	0	75	27	513	ND	ND	12	Y # open: 1 # total: 1	Y univent (off)	N	Hallway DO, #MT/AT: 1, DEM, PF.
multi purpose room	3	71	29	607	ND	ND	13	N	Y wall (off)	Y wall (off)	Hallway DO, Exterior DO, 75 occupants gone 5 min.

ppm = parts per million
µg/m3 = micrograms per cubic meter

AD = air deodorizer
AP = air purifier
aqua. = aquarium

AT = ajar ceiling tile
BD = backdraft
CD = chalk dust
CP = ceiling plaster
CT = ceiling tile
DEM = dry erase materials

design = proximity to door
FC = food container
G = gravity
GW = gypsum wallboard
M = mechanical
MT = missing ceiling tile

NC = non-carpeted
ND = non detect
PC = photocopier
PF = personal fan
plug-in = plug-in air freshener
PS = pencil shavings

sci. chem. = science chemicals
TB = tennis balls
terra. = terrarium
UF = upholstered furniture
VL = vent location
WP = wall plaster

Comfort Guidelines

Carbon Dioxide: < 600 ppm = preferred
600 - 800 ppm = acceptable
> 800 ppm = indicative of ventilation problems

Temperature: 70 - 78 °F
Relative Humidity: 40 - 60%

Douglas Waybright School

25 Talbot Street, Saugus, MA 01906

Table 1

Indoor Air Results

Date: 04/27/2006

Location/ Room	Occupants in Room	Temp (°F)	Relative Humidity (%)	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	TVOCs (ppm)	PM2.5 (µg/m3)	Windows Openable	Ventilation		Remarks
									Supply	Exhaust	
main office 12:57 pm	1	72	32	649	ND	ND	13	Y # open: 0 # total: 2	N	N	Hallway DO, local AC,
nurse	1	72	32	647	ND	ND	19	Y # open: 0 # total: 2	N	N	Inter-room DO, PF.
principal	0	72	32	623	ND	ND	12	Y # open: 0 # total: 2	N	N	Inter-room DO, local AC, PF.
teachers' lounge	5	72	32	629	ND	ND	14	Y # open: 0 # total: 2	N	N	Hallway DO, local AC,

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